Forecasting the Outcome of Closed-Door Decisions: evidence from 500 years of betting on papal conclaves

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Abstract

Closed-door decisions may be defined as decisions in which the outcome is determined by a limited number of decision-makers and where the process is shrouded in at least some secrecy. In this paper, we examine the use of betting markets to forecast one particular closed-door decision, the election of the Pope. Within the context of 500 years of papal election betting, we employ a unique dataset of betting on the 2013 papal election to investigate how new public information is incorporated into the betting odds. Our results suggest that the market was generally unable to incorporate effectively such information. We venture some possible explanations for our findings and offer suggestions for further research into the prediction and predictability of other 'closed-door' decisions.

JEL codes: D72, G14, L83, Z12

Keywords: closed-door decisions; information; Papal conclave; market efficiency.

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1. Introduction and Motivation

The forecasting of decision-making in the context of elections and public policy is the subject of an extensive literature. An increasingly significant part of this work considers the relevance and efficiency of betting or prediction markets in making these decisions (e.g. Page, 2011; Saville et al., 2011). Betting on election outcomes has a long history, and is particularly well-documented in the case of presidential elections in the US (Rhode and Strumpf, 2013), where it has been traced, according to contemporaries, back to the election of George Washington, and has existed in organised markets since the administration of Abraham Lincoln.

Within the context of political betting and forecasting, we can distinguish between open- and closed-door decisions. The former are open to public scrutiny whilst the latter can be defined as decisions taken by an individual or group of individuals whose choices are shrouded, at least from outsiders, in a layer of secrecy. Examples of closed-door decisions include court rulings and verdicts.

The forecasting of closed-door decisions has attracted a less extensive literature, confined for the most part to the prediction of US Supreme Court rulings (e.g. Epstein et al, 2010; Johnson et al., 2009; Ruger et al., 2004), and only a very small part of this literature considers the relevance or efficiency of betting or prediction markets in making these decisions (Blackman et al., 2012; Cherry and Rogers, 2006).[1] Other closed-door decisions which have attracted particular notice in the context of betting markets include appointments to the Supreme Court and Vice-Presidential running mates for US Presidential nominees of the main parties. In particular, the real-money prediction market, TradeSports, was showing, before the nomination of Judge John Roberts, an implied probability of 80 per cent that Judge Edith Clement would be appointed (Sunstein, 2006, p.105-6). Until "roughly two hours before the official announcement, the market was more or less completely ignorant of the existence of John Roberts, the actual nominee." (Ibid, p.120). In the context of the appointment of a Supreme Court Justice, it might of course be expected that there is a very

[1] Nevertheless, a recent analysis of the 2012 Supreme Court decision about the 'Affordable Care Act' does support the value of expert forecasters in predicting Court decisions (Vaughan Williams, 2014). It is noted that the eventual outcome was one which might have been read months before the decision through close scrutiny of the findings of the American Bar Association's (2012) survey of a select group of Supreme Court experts. In this respect, the expert forecasters performed significantly better than the real-money exchange betting market.

high value placed on the protection of such privileged information. "The high value placed on keeping one's confidences in the legal and political arena can make exorbitant the price of inducing a knowledgeable person to place a bet" (Harvard Law Review, 2009, p.1228).

Betting markets might be particularly susceptible to failure in the case of events that are dependent on the decisions of a single person or very small number of people. Examples include the outcome of jury trials, notable examples being markets offered about the outcome of the OJ Simpson trial in 1995[2] and the Michael Jackson trial in 2005[3]. In both cases, the markets erred on the side of conviction. TradeSport's market in 2005, which gave Karl Rove a 65 per cent chance of being indicted in relation to the disclosure of the identity of a CIA agent (Sunstein, 2006, p.136), erred in the same direction, as did the 75% implied probability recorded on Intrade for Governor Tim Pawlenty to become Senator McCain's running mate in 2008, hours before Governor Sarah Palin (who barely registered for the duration of most of the market) was announced.[4] In 2012, there was a movement in the betting markets toward Rep. Paul Ryan to be Governor Romney's running mate in the final days running up to the announcement[5], which proved prescient, but an analysis of the prevalence of tweeting about the potential nominees in the same period arguably provided a more valuable guide to the outcome of Governor Romney's closed-door decision.[6]

Most closed-door decisions have never been the subject of trading in betting markets. However, there seems little doubt that improved forecasts of the outcome of these decisions would be very valuable to affected parties. These decisions may range from the deliberations of the Executive branch of Government on whether to launch a ground invasion of another country to the Bank of England Monetary Policy Committee decisions on the level of interest rates. Cherry and Rogers (2006, p. 1160) summarize the problem of forecasting closed-door decisions using betting markets this way:

"While information markets do an excellent job of aggregating information and making predictions, they are not mind-reading devices."

Given that most closed-door decisions have not been the subject of trading in betting markets, there has been very little proper analysis conducted into how well they incorporate

[2] http://articles.latimes.com/1995-10-05/news/mn-53643_1_simpson-trial
[3] www.ritholtz.com/blog/2005/06/the-prediction-markets-chalk-another-one-up/
[4] Steve Kornacki, 'Intrade Loves Pawlenty's Chances', N.Y. Observer, Aug. 28, 2008, www.observer.com/2008/politics/intrade-loves-pawlentys-chances.
[5] http://abcnews.go.com/blogs/politics/2012/08/odds-of-romney-picking-paul-ryan-as-vp-double-in-political-betting-market/
[6] http://readwrite.com/2012/08/13/how-twitter-predicted-romneys-vp-choice

information, how well they can distinguish signal from noise, and what insight they can give us into the outcome of the closed-door decision.

This paper seeks to address this gap in the literature in the context of a closed door decision for which betting markets have existed for at least 500 years, the outcome of papal conclaves. The decision over the choice of pope is of considerable significance for a number of reasons. The pope is perhaps the last absolute monarch (Padovano and Wintrobe, 2013) and, as such, exercises a very significant degree of influence over the shape and direction of the Catholic Church. In turn this has a direct impact on the lives of millions of Catholics world-wide. Further, due to the widespread activities of the Church in the fields of health, education, economic development and diplomacy, the selection of a pope has a global significance well beyond the immediate sphere of the Catholic Church.

This is also an interesting type of election in that the electorate might be regarded as relatively 'non-complex', defined by Jottier et al. (2012) in terms of size and heterogeneity. Jottier et al. argue that in such cases, prediction accuracy should be high relative to where there are larger, more heterogeneous electorates.

The specific focus of this paper is to examine how efficiently (or otherwise) the papal betting markets incorporated both public and private information revealed during the course of the conclave. In this task, we are fortunate in having access to a unique dataset which provides detailed information on the betting market for every potential papal contender. In the next section of the paper, we draw together several sources to summarise what is known about gambling in historical papal elections. We then explain the background and context for betting on the 2013 conclave. In section 4, we introduce our data and the empirical methodology we employ. Finally we report and discuss our empirical results.

2. Betting on Papal Elections: the historical context

We summarise the available information on betting in conclaves in Table 1. The first recorded example of betting on a papal election was the papal conclave of 1503, at which time it was considered already "an old practice" (Baumgartner, 2003 p.250; Villard, 2009). The brokers in the Roman banking houses who made books and offered odds on who would be elected,[7] made Cardinal Francesco Piccolomini the 100 to 30 (against) favourite, ahead of Cardinals Guiliano della Rovere (100 to 15) and Georges d'Amboise at 100 to 13 (Baumgartner, 2003 p.88) Although Piccolomini is thought to have trailed in the first round

[7] See Hunt (2012 pp. 367-8) for details of how and where they conducted their operations.

of voting with 4 votes to 13 for d'Amboise and 15 for della Rovere, Piccolomini apparently benefited from a switch of votes from d'Amboise to himself in subsequent voting, and duly became Pope Pius III. The bookmakers were proved right.

The next conclave for which we have the betting odds is that of December, 1521, in which odds were offered on no fewer than twenty cardinals. Giulio de'Medici, the cousin of Leo X, was the betting favourite, at 100 to 25 (4 to 1), followed closely by Cardinal Alessandro Farnese at 100 to 20 (5 to 1), whose odds shortened to 100 to 40 (5 to 2) after a Roman mob plundered his house (Baumgartner, 2003 pp. 95-6). Though Farnese at one point came close to being elected pope, he could not reach the required two-thirds of the vote (Brewer, 1920 p. 798), and ultimately the cardinals looked outside of the conclave, electing Adriaan Florensz (Adrian of Utrecht) as Pope Adrian VI.

During the papal conclave of 1549-1550, the Venetian ambassador, Matteo Dandolo, describes how Cardinal Gianmaria del Monte (who was eventually elected Julius III) had opened in the betting as the 5 to 1 favourite, but within three days Cardinal Reginald Pole had been established favourite at odds of 4 to 1 (CSP, 1970 p.274-6). On December 5, as balloting began, Pole was clear favourite at 100 to 95. On that day, he received 26 votes, two votes short of the 28 votes that would have given him the two-thirds majority required to elect him Pontiff. Although on the point of being made pope by acclamation, Pole insisted on waiting until he won the formal two-thirds majority (Baumgartner, 1985 p. 306). By the time that four additional French cardinals, opposed to Pole, arrived December 11, however, he was trading at 5 to 2, and a month later he was being offered at odds of 100 to 16 (Baumgartner, 2003 pp.108-9). Proceedings within the conclave leaked to the bankers offering odds and others (Baumgartner, 1985, p. 305). Indeed, Dandolo had reported to his superiors early in the conclave: "It is more than clear that the merchants are very well informed about the state of the poll, and that the cardinals' attendants in Conclave go partners with them in wagers, which thus causes many tens of thousands of *scudi* (crowns) to change hands" (CSP, 1970 p.281).

In the first conclave of 1590, Sfondrato had been trading at 100 to 11, trailing Giambattista Castagna, who was offered at 100 to 22 before being elected Pope Urban VII. The second 1590 conclave is the earliest in which reports of insider trading by cardinal electors emerged. Cardinal Gabriele Paleotti was a strong favourite with odds at one point reflecting a 70 per cent chance of winning (Biblioteca Apostolica Vaticana, 1590, cited in Hunt, 2012, p.370). Two influential cardinals, Montalto and Sforza, are reported to have secretly agreed to join forces in support of Niccolo Sfondrato (Baumgartner, 2003, p.135).

They consequently made fortunes betting on him at odds of 10 to 1 the day before he was elected as Pope Gregory XIV.

Extensive gambling is also recorded on the papal conclaves of 1903 and 1922, but there is no available record of the odds themselves (Rhode and Strumpf, 2013, p.562). Johnson (1974) reports bookmaker odds in Milan for the 1958 conclave which show Cardinal Angelo Roncalli the 2 to 1 favourite, followed by Cardinals Agagianian and Ottaviani at 3 to 1, then Stefan Wyszynski and Giuseppe Siri at 4 to 1. The odds were justified when Roncalli became Pope John XXIII.

For the first conclave of 1978, bookmakers in London were offering odds of 5 to2 about Cardinal Sergio Pignedoli, 7 to 2 about Sebastian Baggio and Ugo Poletti and 4 to 1 about Carlo Benelli. The best odds about a non-Italian were 8 to 1 about Johannes Willebrands. Of these only Pignedoli showed any strength in the voting, unconfirmed reports of the voting indicating that he obtained about 18 votes in the first ballot, compared to about 23 for Albino Luciani and 25 for Giuseppe Siri. Ultimately, Luciani became Pope John Paul I.

For the second conclave of 1978, following the death of Pope John Paul I, the Associated Press, on October 14, noted that:

> "Once again, there is no odds-on favourite to be elected as the new pope of the Roman Catholic Church …. Those mentioned most often were Corradi Ursi, 70, of Naples; Salvatore Pappalardo, 60, of Palermo, Sicily; Ugo Poletti, 64, of Rome; Giuseppe Siri, 72, of Genoa; Giovanni Colombo, 75, of Milan; Giovanni Benelli, 57, of Florence, and Antonio Poma, 68, of Bologna … Non-Italian front-runners included Argentinian Eduardo Pironio, 57, and Dutchman Johannes Willebrands, 68."[8]

In fact, Cardinal Carol Wojtyla, archbishop of Krakow, became Pope John Paul II, after the eighth ballot.

In 2005, the man who became Pope Benedict XVI, Cardinal Joseph Ratzinger, opened in the betting, according to the odds offered by the bookmaker, Paddy Power, at 12 to 1. That bookmaker reported taking bets of more than £200,000 on the election, their spokesman calling it the "biggest non-sports betting market of all time."[9] At that point, the bookmaker William Hill made Cardinal Arinze favourite, with Archbishop Tettamanzi, Cardinal Ratzinger and Cardinal Hummes also leading contenders (Fleishman, 2005). At lunchtime on

[8] http://fivethirtyeight.blogs.nytimes.com/2013/03/12/election-of-a-pope-tests-betting-markets/
[9] http://news.bbc.co.uk/1/hi/world/europe/4465591.stm

Tuesday, April 19, after three ballots, Ratzinger was favourite on two out of the three online betting boards monitored by CNN,[10] and by the last day of the conclave he had shortened to a clear 3 to 1 favourite.

Toman (2004) analyses the dynamics of conclave voting using data collected from seven conclaves, beginning with the election of Benedict XV in 1914 through to John Paul II in 1978. Modelling the election procedure using a linear feedback count panel data model, she found three significant patterns. First, that the number of votes obtained during the previous ballot is strongly and positively correlated with the votes obtained during the ongoing ballot. Secondly, she found a momentum effect, so that the growth in votes a cardinal obtains between the previous ballot (at time t-1) and the one before that (time t-2) is positively correlated with votes obtained during the current ballot (time t). In other words, candidates tend to give more votes to a cardinal whose votes are seen as growing, and vice-versa. Finally, the effect of "nocturnal conversations" (discussions made after the end of the day) tends to sizeably reduce the number of votes obtained by the cardinal leading in the vote. A possible explanation for this finding is that these conversations allow cardinals to coordinate and hinder the election of the leading cardinal.[11]

In summary, papal conclaves do have some history, dating back to 1503, of electing one of the favourites in the betting, but this is by no means a general rule, and there is some evidence of predictable patterns of voting. The historical evidence is that the betting markets have a patchy record in assimilating information about the identity of the next pope, but there is clear historical evidence, not least from tracking movements in the betting odds during the course of the conclave, that the markets do show evidence of having picked up in a number of documented cases genuine information of predictive value about the outcome of papal elections.

3. The 2013 Conclave

We now turn to the 2013 conclave which eventually led to the election of Cardinal Jorge Bergoglio as Pope Francis I. In the run-up to the conclave, a survey of Vatican watchers[12] by YouTrend.It listed Cardinal Timothy Dolan of the United States as the second most likely

[10] Tammy Oaks, 'Bookmakers lay odds on new pope' April 19, 2005, CNN.com. http://edition.cnn.com/2005/WORLD/europe/04/18/pope.betting/

[11] See also: www.linkiesta.it/blogs/una-firma-di-tutto-riposo/how-do-cardinals-vote-statistical-analysis-papal-conclaves

[12] www.youtrend.it/2013/03/12/totopapa-sondaggio-youtrend-vaticanisti-previsioni-papabili/

pope, after Cardinal Angelo Scola, followed in order by Cardinals Marc Ouellet, Odilo Scherer and Thomas O'Malley. Luis Tagle of the Philippines was ranked sixth.

An analysis was also reported in the National Catholic Register[13]of the likely age of the incoming pope based on three trends – age at vacancy, length of reign and age at election. In terms of age at leaving office, the last several popes (except for John Paul 1) were over 80 years old, a result of a rising trend over the last 500 years. A similar rising trend in the length of reign indicates that a reign of 15 years is now an indicative guideline. An upward, though less steep, trend in the age at election, indicates that someone in their late 60s (around 68) is a good guideline. In conclusion, this analysis pinpointed the expected age of the new pope to be about 68, and to be expected to reign for about 15 years. More generally, the analysis concluded that "the next pope is likely to be between 60 and 70." Of the 115 cardinal electors, 47 were in this age range. Jorge Bergoglio (76) was not one of them.

Of perhaps more significance than age is country or region of origin. In particular, a Pew Research Report[14] examining the regional distribution of the world's Catholics showed that while 65% of Catholics lived in Europe in 1910, by 2010 that had declined to 24%, while the share in Latin American –Caribbean countries rose from 24% to 39%, in Asia-Pacific countries from 5% to 12%, in Sub-Saharan Africa from less than one per cent to 16%, and in North America from 5% to 8%. Middle East-North African countries made up less than one per cent in both periods. Of arguably more importance than the regional distribution of the world's Catholics, however, may be the regional distribution of the 115 attending cardinal electors. Of these, 28 were from Italy, 32 from the Rest of Europe, 20 from North America, 13 from South America, 11 from Africa and 11 from Asia (including the Middle East) and Oceania. For the 2005 conclave, the corresponding figures were 39 from Italy, 30 from the Rest of Europe, 17 from North America, 9 from South America, 10 from Africa and 10 from Asia (including the Middle East) and Oceania.

An assessment released on March 12, 2013, noted that "Almost like clockwork since 1878, every election has alternated between producing a favourite, and an almost complete surprise. In 2005, 1963, 1939, 1914 and 1878 the cardinal electors played it safe, while in 1978 (twice), 1958, 1922 and 1903 they were prepared to 'roll the dice', often in order to break a deadlocked conclave. If this pattern holds, 2013 will produce a (late) surprise …

[13] Jimmy Akin, 'How Old Will the Next Pope Be?' National Catholic Register, February 25 2013. Available at: http://www.ncregister.com/blog/jimmy-akin/how-old-will-the-next-pope-be

[14] Pew Research Religion & Public Life Project, 'The Global Catholic Population.' February 13, 2013. Available at: www.pewforum.org/2013/02/13/the-global-catholic-population/

Could the surprise be the first non-European pope in 1,282 years? …. After all, two-thirds of Catholics now reside outside of Europe, forecast to grow to three-quarters by 2050 …"[15]

What is most notable about the pre-conclave speculations is how little attention was paid by observers to the chances of Cardinal Bergoglio. John Allen Jr. (the Vatican expert for the US publication, The National Catholic Reporter) was unusual in at least profiling Bergoglio as a possible contender, albeit in the context of profiles of over twenty other 'papabile', although he was rather ambivalent about Bergoglio's chances.[16]

We now look at events during the process of the conclave itself. We are particularly interested in examining how far new information (either private or public) that became available during the conclave might have influenced perceptions about the outcome.

In doing so, it is important to highlight the very different informational context in which this conclave was being conducted compared to all others from 1603 up to and to some extent including 2005. Most notable is the emergence in recent years of electronic blogging, and most recently of the micro-blogging site, Twitter. This provides useful context for our consideration of the historical context, in that we might expect the speed and easy dissemination of, and access to, information relating to the most recent conclave would make the betting markets particularly efficient. If there are inefficiencies in the processing of public information in this context, it is all the more remarkable if the betting markets were able to arbitrate between signal and noise in earlier conclaves.

Significant additional context here is offered by Vaughan Williams and Reade's (2014) analysis of the response of the 2010 UK election betting markets to the emergence via Twitter of a major and unexpected event on the campaign trail. It is shown in that study that the betting markets responded very hesitantly to the emergence of the news on Twitter, only starting to show a significant reaction when the news was picked up and reported in the mainstream media.

It is, therefore, particularly interesting in this analysis to examine the reaction of the markets to the emergence of new public information through this lens of micro-blogging, blogging and mainstream media dissemination.

In doing so, we focus on four significant events as follows:

A. 18:41 GMT on Weds 12th March. This is when the first black smoke appeared, indicating that the cardinal electors had not agreed on a pope following the first

[15] Rod Crosby, http://ncronline.org/blogs/ncr-today/papabile-day-men-who-could-be-pope-13
[16]http://ncronline.org/blogs/ncr-today/papabile-day-men-who-could-be-pope-13

round of ballots. At this point in time, the cardinals exit the Sistine chapel where the voting takes place, and the first opportunity arises for the leaking of private information on the first voting tallies.

B. 08:10 GMT on Thurs 13th March, publication of a 'Vatican Insider'[17] report in La Stampa by Vatican reporter, Giacomo Galeazzi, identifying the group of candidates leading the ballot, namely Cardinals Scola, Scherer, Bergoglio, Ouellet and Dolan.[18] This is apparently the first and only report in the public domain claiming to know the state of the voting, and was offering what we now know to have been reliable information on the progress of the ballot. This was the also the first credible report indicating that Cardinal Bergoglio was a serious contender. What is particularly important to note here is that 'Vatican Insider', and Giacomo Galeazzi in particular, are sources which were at the time already very well regarded by informed observers.[19] These were also released via a link on the Vatican Insider Twitter Feed (@vat_insider_it).

C. 10:38 GMT on Thurs 13th March, second black smoke revealing that the second round of ballots had not led to a pope being elected. This indicates a second point in time when new but private information was available.

D. 11:12 GMT on Thurs 13th March, update reported by Galeazzi and posted on the Vatican Insider Twitter feed, suggesting that, in the most recent round of voting, the shortlist of candidates had reduced to just three: Scola, Bergoglio and Ouellet.[20] At 11.57am, the Guardian, a UK national newspaper with a significant Internet presence, reported on the two Galeazzi articles on their Liveblog, thus bringing this information to the attention of a much wider, English-speaking audience.[21]

A subsequent report, published in La Repubblica after the election of the Pope, claims that Scola received approximately 35 votes in the first vote, to 20 for Bergoglio and 15 for Ouellet,[22] an account backed up in broad terms by informal post-conclave interviews with five cardinal electors by John Allen Jr. at the National Catholic Reporter - which additionally reported support for Scherer. Allen continues that "After two rounds of voting Wednesday

[17] http://vaticaninsider.lastampa.it/en/about-us/
[18] http://vaticaninsider.lastampa.it/vaticano/dettaglio-articolo/articolo/conclave-23167/
[19] http://ncronline.org/blogs/all-things-catholic/ferment-religious-life-new-american-leader-and-vatican-insider
[20] http://vaticaninsider.lastampa.it/en/the-vatican/detail/articolo/conclave-23177/
[21] www.theguardian.com/world/2013/mar/13/papal-conclave-chooses-pope-day-two-live-coverage
[22] www.ilvelino.it/it/article/orenove5-papa-in-conclave-un-plebiscito-quasi-cento-voti/493c9365-6d5a-44a7-9763-11c9364f38d3

morning, it had become clear that neither Scola nor Scherer were likely to cross the finish line and gain the 77 votes needed for election … The fourth ballot, the first of Wednesday afternoon, saw Bergoglio separate himself from the pack."

So it is clear that both Galeazzi reports on the outcomes of each round of voting (the second one subsequently picked up and reported in the Guardian's 'Liveblog') are cases in which accurate information, of great significance to the eventual outcome, was made publicly available. It is interesting to observe that even the order of listing of the final three names coincided with the vote tally as reported on 19th March in La Repubblica. More importantly, by comparing the Galeazzi update with the earlier report, it seems clear that Bergoglio's vote tally was rising, while the early front-runners had failed to reach the required two-thirds majority by the time of the 'nocturnal conversations'. For these reasons, we might have expected the reports to have led to a surge of betting interest on Cardinal Bergoglio, unless there was good reason to question the credibility of the Vatican Insider reports. We might also expect to have seen a flight of money away from previously favoured candidates not mentioned in the reports.

In the next section we examine how prices for the key contenders actually responded to the release of both private and public information.

4. Methodology and Data

We examine prices throughout the time that the Betfair market on the Conclave was open. For our purposes, price is defined as the probability of a contender winning the election as implied by the Betfair odds. As described above, during this time we identify four key time points (A to D) at which significant additional information was potentially available to the market.

Events A and C provided public information to the extent that they revealed that no pope had been elected. What is important is that at these points in time insiders who were aware of the breakdown of votes in the inconclusive ballots would have been in possession of information unavailable to the general public regarding the likely prospects of the key contenders. In principle, this information could have been exploited to engage in insider trading on the betting markets.

Events B and D indicate points at which that same information was made publicly available. At 11:57 on 13th March (a little under one hour after Event D, the publication of the second La Stampa article) the Guardian live blog reported on the article, naming the three remaining contenders and hence publicising this information more widely to an English-

speaking audience. We consider the implications of the publication of the Guardian blog below.

The betting data we use comes from Betfair, the world's largest person-to-person betting exchange. Betfair supplied us with a unique dataset comprising a complete record of every bet (recorded and time-stamped in-running) for every candidate in the papal election. Each record includes the amount bet, the price achieved and the timestamp. For the majority of our analysis we aggregate the data up to the hourly level to ensure there is a reasonable level of liquidity. The mean size of a wager in the papal conclave was just over £10. In total, over the course of the market, over 17,000 bets were placed giving a total sum wagered of £180,312. Anyone located in Italy, however, at the point of trading, was unable to place a bet through Betfair on the conclave, which is potentially significant if those with most confidence in the accuracy of the information relating to the election result were based in that country.

Our approach is to track graphically prices at the end of each hour on the betting markets of the main contenders over the final twenty four hours of the conclave market and to examine the effect on prices at each of these points. We identify two groups of contenders. The first group comprises the five cardinals identified by La Stampa (and subsequently verified by other sources) as having attracted significant numbers of ballots in the early rounds of voting. The second group comprises the six other cardinals who were most favoured in the betting odds at the opening of the market, specifically Cardinals Bertone, Erdo, O'Malley, Schonborn, Tagle and Turkson.

Having examined the impact of our four events on the prices of each cardinal, we then go on to estimate a formal econometric model of market efficiency for each of the three main contenders (as revealed by the second La Stampa report and subsequently verified by other sources). We use a standard approach to testing for information inefficiencies by testing whether past movements in asset prices can be used to predict positive returns. On the assumption of an efficient market, current returns should follow a random walk process and lagged returns should have no explanatory power. When estimating such models, it is important to take account of the impact of time-varying volatility, or Autoregressive Conditional Heteroscedasticity (ARCH) (Engle, 1982). Not doing so is likely to lead to biased and inconsistent estimates. There exist a whole class of models to deal with ARCH effects. Most common in the analysis of asset prices is the use of Generalised ARCH (GARCH) models (Bollerslev, 1986). In these models, the time-dependent volatility is estimated as a function of observed prior volatility, measured as the lagged value(s) of the

squared regression disturbances and, also, lagged value(s) of the conditional variance. The order of the GARCH model is given by the number of lags in each case.

In the context of market efficiency for asset prices, the GARCH(p, q) model can be represented as follows:

$$R_t = \alpha_o + \sum_{i-1}^{k} \alpha_i R_{t-k} + \varepsilon_t \quad (1)$$

$$\sigma_t^2 = \gamma_0 + \sum_{i=1}^{i=q} \gamma_i \, \varepsilon_{t-1}^2 + \sum_{i=1}^{i=p} \delta_i \sigma_{t-i}^2 \quad (2)$$

where R_t represents returns in hour t, ε_t is assumed to follow a normal distribution with zero mean and variance σ^2; γ_i are the ARCH parameters; δ_i are the GARCH parameter(s). We define returns on hour t in the normal way as $R_t = \log(P_t/P_{t-1})$ where P_t is the betting price for the contender at the end of hour t. We use the Akaike Information Criterion (AIC) to determine the optimal lag length of the ARCH and GARCH parameters.

We supplement equation 1 by the inclusion of dummy variables for each of the four time points identified above. We include one lag of event D (publication of the second La Stampa article) to allow for the further dissemination of the information via the Guardian. Significant coefficients on dummy variables for events A and C will provide information on the extent to which private information held by insiders was incorporated into the market. The coefficients for events B and D indicate how the market incorporated public information. We would expect the effect of these dummy variables to vary with each contender. In particular, for Cardinal Bergoglio who was not originally considered by the markets to be a realistic contender, we would expect a significant and positive coefficient for the two public information dummies. A positive coefficient for the two private information dummies would indicate significant trading by insiders on the basis of such information.

We estimate this model using hourly data from the opening of the market as 21.00 GMT on the 28th February until the close of the market at 18.00 GMT on the 13th March. This gives us a total of 310 observations.

5. Results

In Figures 1a and 1b we track hourly mean price for individual cardinals in the critical final 24 hours period of betting. We present plots for two groups of cardinals. The first is those identified *ex post* as having attracted significant numbers of votes in the early rounds. The second are those cardinals who were expected to poll well prior to voting but who were

identified *ex post* as receiving few or no votes. We also present (in Figures 2a-2c) more detailed minute-by-minute graphs over the final 24 hours of the conclave for the three candidates who attracted significant votes in the final rounds of voting.

Taking each of our events in turn, event A (the first appearance of black smoke) indicates a time at which insiders would have been aware that the first group of cardinals (reported in Figure 1) were all still in the running, whereas the chances of those in the second group (who had originally attracted a lot of betting but did not attract many or any votes) had clearly been overestimated. In fact, the time paths provide very little evidence that insiders exploited this information to any significant degree. In many cases, prices changed very little after that point or continued on a previously established trend. Indeed, in some cases the graphs suggest a perverse effect. For example, Cardinal Turkson's price increased markedly in the period soon after event A, contrary to what we would expect if insiders were exploiting their private information. Looking at the two candidates (Bergoglio and Dolan) who attracted votes despite previously not being thought of as serious contenders, if anything prices seem to drop after event A. A close look at the minute-by-minute data for Bergoglio (Figure 2a) confirms an increase in volatility around the time of event A, and the price eventually settles at a lower value than before the black smoke, the opposite to what we would expect had the private information made available at that point (namely that Bergoglio had attracted a significant number of votes) been exploited in the markets.

Event B indicates the point at which the private information becomes public. Again, there is little consistent pattern in the data to suggest that the markets successfully incorporated this information. Indeed, there is very little movement in prices at all at this point, one exception being that Scola's price gradually moves upwards after event B (see Figure 2b).

Event C (the second appearance of black smoke) marks the second period in which there was potential for insider trading. This period lasts just one hour before the voting information was made public by La Stampa (event D). Again, there is no clear evidence that the prices of the candidates reacted in a way consistent with what we would expect if there was insider trading, although Bergoglio's price does appear to increase marginally after this point. At the time of Event D, Bergoglio's odds of winning appear to drop at first (again the opposite of what we would expect). His price eventually rises significantly, in line with expectations, and the timing of this lagged response matches the subsequent re-posting of the La Stampa report by The Guardian. There are other apparent inconsistencies. For example,

Schonborn's odds of winning increase markedly soon after Event D, despite there being no public indication (as far as we are aware) to indicate an increase in his chances.

In Figure 3, we explore further whether there is any evidence of the expected surge in betting on Bergoglio after La Stampa reports (events B and D) revealing for the first time that he was one of the front-runners. In fact, there is very little evidence of any surge. No bets in excess of £10 were placed on Bergoglio in the immediate aftermath of the publication of either of La Stampa reports. After the reports were mentioned on the Guardian blog, there is something of an increase in betting activity but even so the largest bet placed on Bergoglio in the following three hours was just £69. We note that the trading of such relatively small sums is consistent with traders having limited confidence in the accuracy of the information about the election result.

We now go on to look at standard market efficiency regressions for the three candidates who *ex post* were revealed to have attracted the most votes in the conclave, i.e. Cardinals Bergoglio, Ouellet and Scola. In Table 2, we report the level of betting activity for each. Strikingly, quantity of bets and their value are very significantly higher for Ouellet and Scola than for Bergoglio. Indeed, Bergoglio received an average of about 25 bets per day and the most placed on him in any one day was just under £800. In contrast, equivalent figures for Scola were an average of 145 bets per day with a maximum value wagered on one day of over £15,000.

In Table 3, we report the results of simple GARCH models for each candidate using hourly data over the course of the whole market. The models include dummy variables for the hour of occurrence of each of the four events discussed above.

Taking the market for Cardinal Bergoglio first, there is no overall evidence of market inefficiency in that mean returns (as revealed by the constant term) are not significantly different from zero and the lagged returns variable has no significant explanatory power. In contrast, for both Ouellet and Scola, the coefficient on lagged returns is negative and significant suggesting that lagged returns have significant explanatory power.

The results for the four timed events presents us with a mixed picture. The appearance of the first black smoke (event A) is associated with significantly negative returns for Bergoglio and Ouellet, the opposite to what we would expect had insiders used private information that these candidates had attracted a significant number of votes in the early rounds. The second private information event (second black smoke – event C) is more consistent with expectations: for both Bergoglio and Ouellet the coefficient on the dummy variable is positive and significant.

Looking at the revelation of public information regarding voting patterns, the publication of the first La Stampa article (event B) appears to have had little or no effect on returns for Bergoglio. This is striking given that it was the first appearance of any information indicating that he was a front-runner. Intriguingly, the second episode of additional public information (the second La Stampa article – event D) is associated with negative returns at first and only when the Guardian blog further disseminated this information do returns become strongly positive and significant. Taken together, these results are suggestive of the markets processing information in an inconsistent manner and also of significant lags in the processing of public information.

6. Discussion and Conclusions

In summary, there is evidence of some reaction in the betting market to the new information relating to the outcome of the conclave, but in retrospect a clear under-reaction in terms of both extent and speed of incorporation.

In general, online person to person betting markets provide excellent potential for insiders to exploit any inefficiencies in the way the market adjusts to new information. The costs of entry into the Betfair market are low, simply a small up-front deposit into the trading account, and the market was reasonably liquid for clients of the exchange. However, it was not possible to trade from Italy with Betfair on the Conclave. This institutional feature may explain, at least partly, why the market was slow to adjust to newly revealed information. That said, given that the relevant information was widely available and publicised in the UK where Betfair is much better known and very accessible, this cannot be a complete solution.

What can we conclude from these findings? Either that the public release of accurate information from a generally well respected news source was not believed by those able to place a trade on the exchange, or else it was significantly overlooked by traders. In other words, the betting market did not perform as well as might have been expected in terms of responding to new public information, which given its provenance and authoritative tone might have been expected to be accurate, and which indeed turned out to be so. This cannot be explained in terms of the fog of conflicting signals as we can identify no other credible sources issuing conflicting information.

More generally, the main lesson we can perhaps take from this analysis is that decisions taken by individuals or groups of individuals whose choices are shrouded, at least from outsiders, in a layer of secrecy, may not always be as impenetrable as conventional

wisdom about the secrecy of the deliberations might suggest. Rather, it is a question of knowing where to look for the information, and identifying what information to believe.

We venture therefore that in the context of the most recent papal election, sufficient credible information was in the public domain to allow profitable exploitation of this information, yet markets failed to more than very partially reflect this. To this extent, it reinforces the conclusion of Vaughan Williams (2014) about the relatively good predictive power of expert forecasters (American Bar Association) and the relatively poor performance of a major real-money betting exchange market in identifying the high-profile outcome of the 2012 US Supreme Court decision on the 'Affordable Care Act.' It also reinforces the conclusion of Vaughan Williams and Reade (2014) about the hesitant response of the betting markets to the emergence of genuine new information when this information is released via social media. It may also be instructive to consider Brown's (2014) finding of asset mispricing in a relatively simple market (betting on a tennis match), caused by the inability of traders to properly identify and process new information:

> "Traders are bombarded with information … in a variety of forms: newspaper articles, blogs, tweets, broker phone calls and colleague's emails. Even if traders are attentive and receive all of this raw information, it is inevitable that they will be unable to process it effectively …" (Brown, 2014, p.1).

Even so, the failure of the tennis betting market to properly aggregate information in an effective way stands in clear conflict with the weight of evidence found in many other studies of prediction markets about open-door decisions. We infer that the divergence in the efficiency of prediction markets in this context may be attributed to different processes used in discerning and evaluating information in the context of open-door and closed-door decision-making, as well as the slow and uncertain response to information obtained by traders from blogging and micro-blogging sources.

An obvious explanation for the hesitant response to less traditional means of communication is that it is a rational way of filtering rumour from fact. Insofar as this is the explanation, however, it contradicts laboratory studies (DiFonzo and Bordia, 2007) in which subjects are seen to trade on rumours as though they are news, despite the subjects claiming that the rumour sources were non-credible. The disparity may, however, be explained by disparities in the sophistication, incentives and costs of the laboratory subjects and the exchange traders. More pertinent, perhaps, is Benabou and Laroque's (1992) study of how those with access only to public information can evaluate the accuracy of information announced by those with privileged access to information:

> "The fact that privileged information is noisy interferes with the public's attempts to learn whether such announcements are honest …" (p.921) … "many types of individuals with private information … can manipulate public information and asset prices through misleading announcements, and … their ability to do so is limited only in the long run by the public's constant reassessment of their credibility" (p.947).

Placing the current evidence in light of this perspective might help explain at least some of the market under-reaction to emerging new public information. The argument is that bettors shy away from participating in this particular market because there is potential for insider involvement (even if, in the end, there is no foul play and the revealed information is accurate). Also, there is relatively little data, certainly compared to sports and public election betting markets, to help research the likely outcome of a papal election. This is likely to reduce trading volumes and thereby reduce incentives to properly research and process what information is available. The same problems arise in trying to forecast the outcome of a wide range of closed-door decisions.

So the evidence presented here is consistent with the hypothesis that betting markets react slowly and uncertainly to the emergence of new public information when that information relates to closed-door decisions in a variety of contexts, and that this hesitancy is amplified when access to the information is obtained via non-validated blogging and micro-blogging sources. It seems likely, therefore, that the problem in using prediction markets as a guide to the outcome of closed-door decisions is one of trust and validation in two ways.

First, how likely do market participants judge that genuine information about a closed-door decision will be observable and, if observed, disseminated? Secondly, how much trust do market participants place in the source and on the means of dissemination, how much access do they have to both, and how easy is it to sift signal from noise? In the case of the 2013 papal election, it seems that one or more of these factors contributed to the failure to reflect the genuine information in the market price. The fact that it was not possible to trade in Italy on Betfair also potentially acted to hinder some of the parties who might seek to make use of La Stampa's information. To this extent, the condition for maximum efficiency that a prediction market operates unimpeded by government regulations and political pressures (Surowiecki, 2003) and that it operates like an unfettered pari-mutuel market (Ray, 2006), is not fully met.

In other contexts, where signals might be expected to be more observable and to be differentiable from noise, and where reasoned speculation is reported in the mainstream media, say about the likely decision of the Bank of England Monetary Policy Committee on

the level of interest rates, or a policy decision to be taken by the Executive branch of Government, one might expect the prediction market to operate more effectively.

In addition, there is the issue of the complexity of the information flows, in particular how easy it is to distinguish important relevant information from other less relevant or less important information. This will vary between different types of closed-door decision and as well as open-door decisions. Finally, we should be aware of the marginal benefits of identifying, accessing and processing relevant information and the marginal costs of doing so in different contexts.

In conclusion, it is probably for a variety of reasons that the betting markets failed to respond quickly enough, or completely enough, to relevant and important new information revealed publicly about the deliberations in the papal conclave. Ultimately these reduce to the problem of distinguishing signals from noise in an environment where the signal is masked by noise or costly to identify relative to the benefits of doing so, or insufficient trust in the source or means of dissemination of the signal to warrant the risk of acting on it.

In this particular case, the primary source was relatively easy to identify, access and to a large extent trust for traders who knew where to look, but to those accessing the signal through wider second-hand dissemination, the problem of trust in the source of the signal was a real one. Ultimately, though, the information was available to those who could have benefited from it for several hours, but was only marginally incorporated into the market.

A key lesson to be learned from this case, therefore, seems to be that a likely source of trustworthy signals was under-identified and significantly under-exploited. We propose that further research might seek to examine whether similar inefficiencies can be found in the context of other examples of closed-door forecasting, and what can be done to help correct them.

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Figure 1a: Hourly prices for the 5 main Papal Contenders

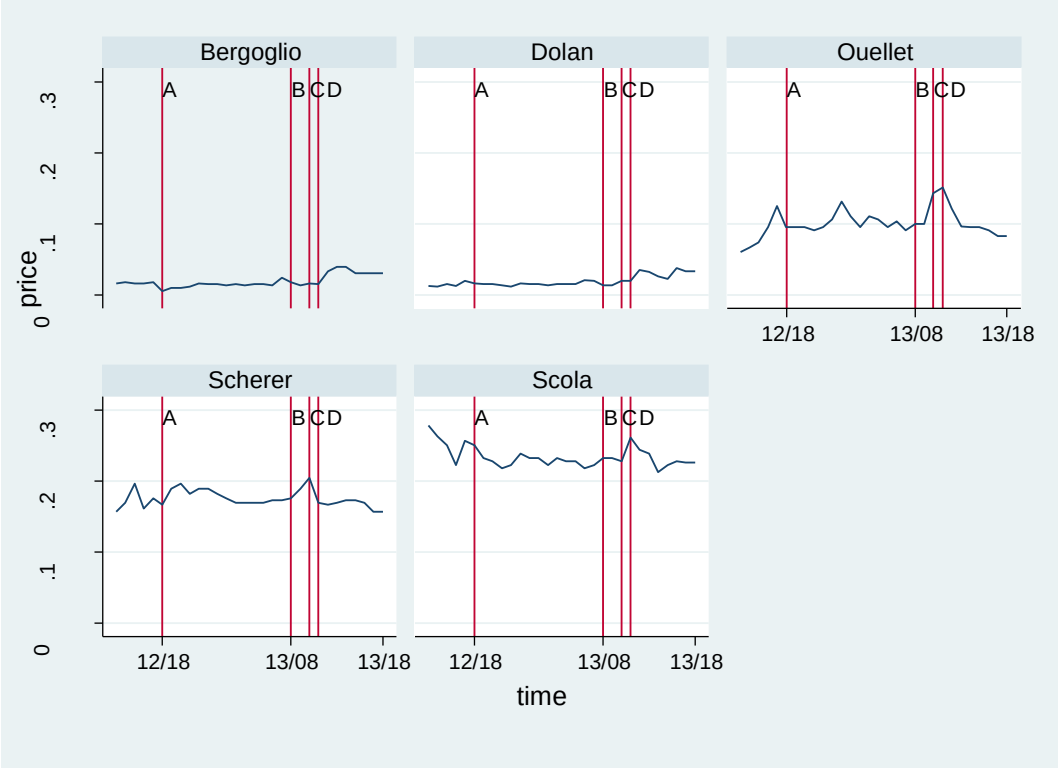


Figure 1b: Hourly prices for the selected other Papal contenders

Notes:
(i) Graphs cover the period from 12:00 GMT on the 12th March 2013 until the closing of the market at 18:00 GMT on the 13th March 2013.
(ii) Price is the probability of that candidate being elected as implied by the Betfair odds on matched bets.
(iii) Vertical lines indicate the timing of each of the events A to D (as described in the text).

Figure 2a: Bergoglio prices minute by minute

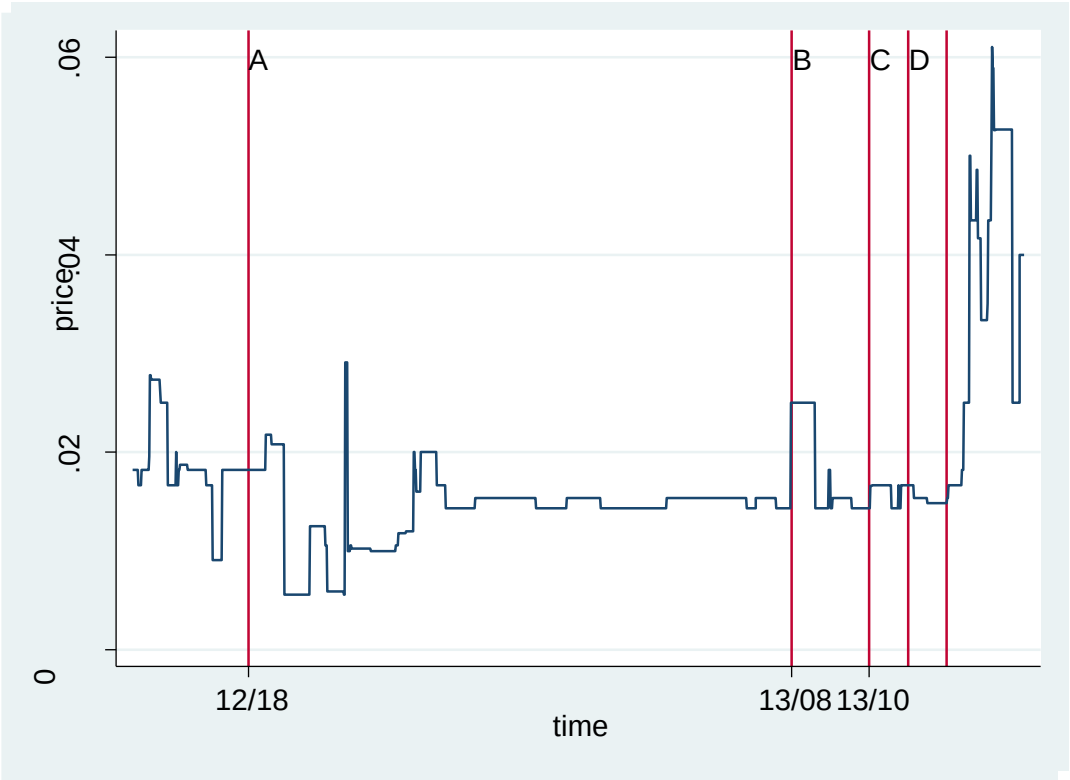


Figure 2b: Scola prices minute by minute

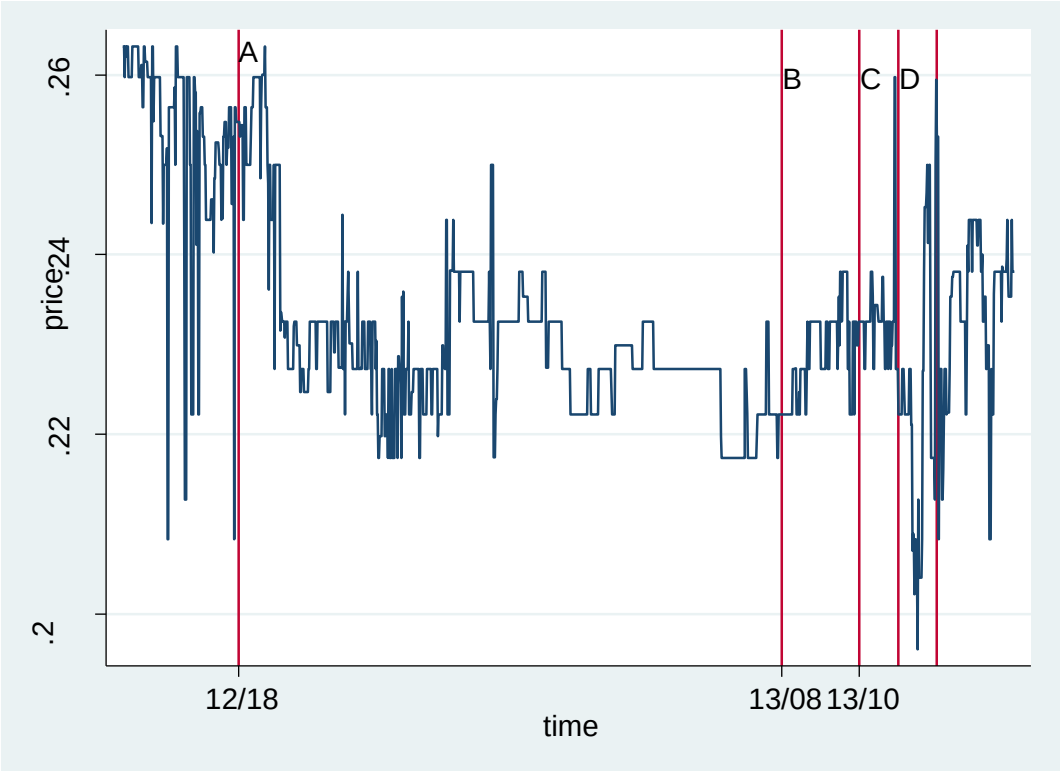
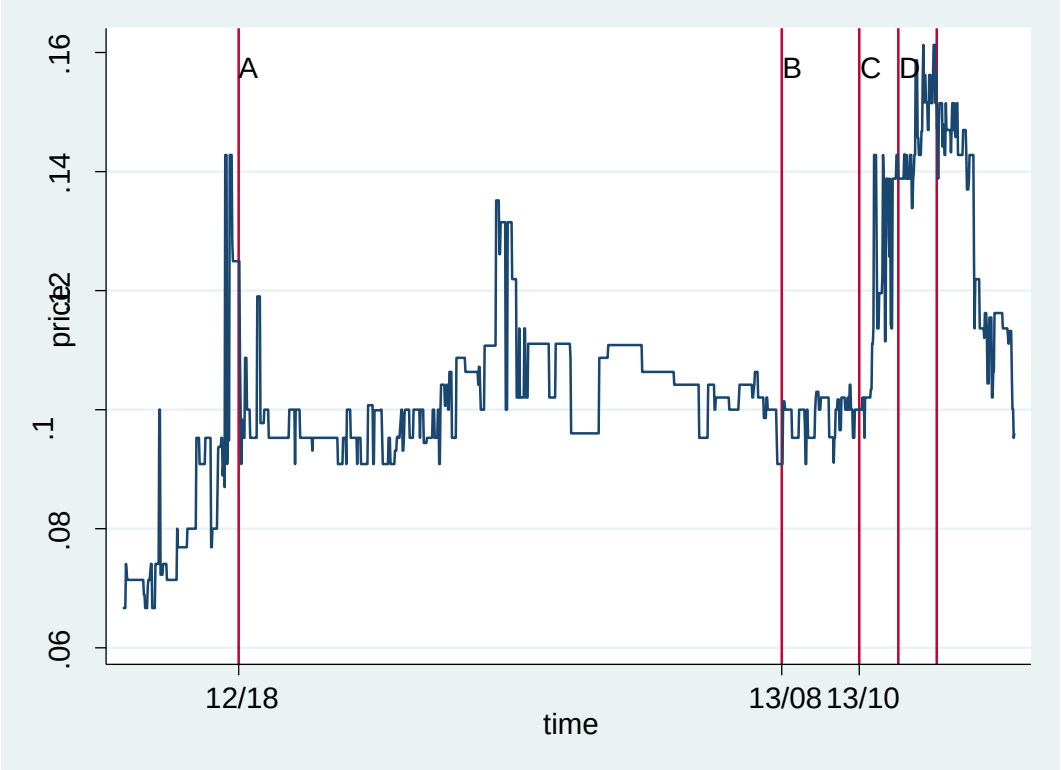
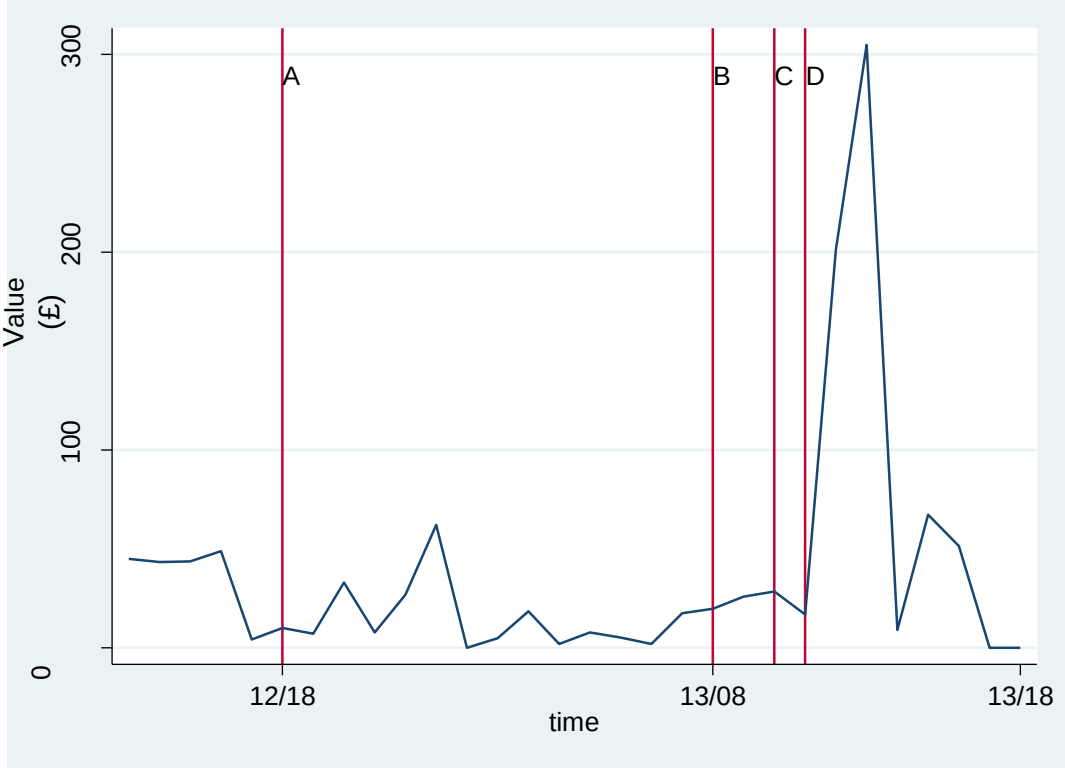


Figure 2c: Ouellet prices minute by minute



Notes:
(i) Graphs cover the period from 12:00 GMT on the 12th March 2013 until 14:00 on the 13th March 2013.
(ii) Price is the probability of that candidate being elected as implied by the Betfair odds.
(iii) Vertical lines indicate the timing of each of the events A to D (as described in the text). The 5th line indicates the Guardian report which further disseminated the public information revealed at point D.

Figure 3: Value of bets on Bergoglio by hour



Notes:
(i) Graph covers the period from 12:00 GMT on the 12th March 2013 until 14:00 on the 13th March 2013.
(ii) Value is the total value of bets placed on Cardinal Bergoglio in each hour.
(iii) Vertical lines indicate the timing of each of the events A to D (as described in the text).

Table 1: Summary of Conclaves for which betting information exists

Conclave	Cardinal elected	Papal Name	Market Details	Odds details
1503	Francesco Piccolomini	Pius III	Odds offered by brokers in Roman banking houses.	Piccolomini was favourite at odds of 100 to 30.
1521-22	Adriaan Florensz (Adrian of Utrecht)	Adrian VI	Odds were offered on twenty different cardinals.	Florensz was outsider and was absent from the conclave when elected. Favourite was de'Medici at 4 to 1.
1549-50	Gianmaria del Monte	Julius III	Significant wagers amongst bankers and merchants. Also reports of widespread leaking of information from the conclave.	del Monte was initial favourite (5 to 1), though later drifted to 2nd favourite to Cardinal Pole the latter priced at nearly evens.
1590 (1)	Giovanni Battista Castagna	Urban VII	Widespread betting, conducted through brokers (sensali). Florentine merchants and bankers, as well as Jewish pawnbrokers, typically worked as brokers.	Castagna offered in the betting at 100 to 22 with Sfondrato at 100 to 11.
1590 (2)	Niccolo Sfondrato	Gregory XIV	First instances of insider trading by cardinal electors reported.	Sfondrato odds were 10 to 1. Paleotti was odds on favourite.
1903	Melchiorre Sarto	Pius X	Widespread gambling reported in international press.	No betting odds available.
1922	Achille Ratti	Pius XI	Widespread gambling reported in international press.	No betting odds available.
1958	Angelo Roncalli	John XXIII	Odds offered by bookmakers in Milan are recorded.	Roncalli was favourite at odds of 2 to 1.
1978 (1)	Albino Luciani	John Paul I	First conclave for which UK bookmakers offered odds. Extensive betting reported. Archbishop of Westminster forbade participation by Catholics.	Luciani was an outsider and his betting odds are unrecorded.

1978 (2)	Carol Wojtyla	John Paul II	Extensive UK betting reported**.**	Woytyla was an outsider and his betting odds are unrecorded.
2005	Joseph Ratzinger	Benedict XVI	Several markets existed amongst both traditional bookmakers and online. First conclave for which betting exchanges offered markets on the outcome.	Ratzinger was initially as long as 12 to 1 with one major bookmaker, but by the end of the conclave was clear favourite at 3 to 1.
2013	Jorge Bergoglio	Francis I	Market very well established through traditional bookmakers and online. High levels of activity and liquidity in markets reported.	Scola was the favourite throughout the process, starting at odds of 4.5 to 1. Bergoglio was an outsider with initial odds of 55 to 1 improving to 32 to 1 by the end of the conclave.

Notes
(i) See section 2 of the text for full details.

Table 2: Level of betting activity for leading Cardinals

Cardinal	Mean bets/day	Max bets/day	Mean value/day	Max value/day
Bergoglio	24.8	103	£129.2	£782.3
Ouellet	87.3	387	£1,092.3	£7.597.2
Scola	145.4	664	£3,089.9	£15,487.8
All Cardinals	**668.8**	**5,218**	**£6935.1**	**£59,785.6**

Notes

(i) Figures refer to all matched bets placed on Betfair.

Table 3: ARCH Estimates of Returns in Papal Contender Markets

	1	2	3
	Bergoglio	**Ouellet**	**Scola**
Return (t-1)	-0.116 (0.130)	-0.283*** (0.087)	-0.334*** (0.111)
A. Black Smoke 1	-0.937*** (0.200)	-0.187*** (0.024)	0.022 (0.050)
B. La Stampa 1	-0.003 (0.171)	0.065*** (0.013)	0.053*** (0.005)
C. Black Smoke 2	0.121*** (0.034)	0.364*** (0.005)	-0.023*** (0.004)
D. La Stampa 2	-0.067*** (0.020)	0.127 (0.123)	0.131*** (0.003)
La Stampa 2 (t-1)	0.759*** (0.015)	-0.328*** (0.093)	-0.022 (0.017)
Constant	0.005 (0.008)	-0.008* (0.005)	1.233 e-4 (3.73 e-3)
Log-Likelihood	177.39	343.63	443.09
AIC	-336.78	-669.26	-868.18
N	310	310	310

Notes

(i) Sample period is 21.00 GMT on 28th Feb until 18.00 GMT on 13th March.

(ii) Dependent variable is the Betfair return for hour t, defined as $\log(P_t/P_{t-1})$ where P_t is the mean Betfair price at the end of hour t.

(iii) Figures in brackets are standard errors.

(iv) *** indicates significance at the 1% level; ** at the 5% level;* at the 10% level.

(v) AIC is the Akaike Information Criterion for model selection and is calculated as AIC = -2(L - k) where k is the number of parameters being estimated. The AIC suggests a maximum lag order of one for the ARCH and GARCH terms.